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Storage of Edible Nuts

by

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STORAGE OF EDIBLE NUTS

In an earlier report (H. T. & S. Office Report No. 240, March 27, 1951) data were presented on preliminary tests made by the Bureau of Plant Industry, Soils and Agricultural Engineering on the storage of edible nuts. This investigation has been continued and it is the purpose here to summarize the results which have been obtained since the initiation of the project in 1949.

The object of this study is to develop methods of storing and handling nuts which will prevent or retard undesirable changes that occur during the period between harvest and consumer use. Unless proper precautions are taken during this interval, nuts may become stale, rancid, moldy, dark in color, absorb odors and flavors from other products with which they are stored or become infested with insects. Any of these can cause serious damage to quality or render the product unfit for use. Shelled nuts are especially susceptible to damage of the types mentioned and therefore require greater care in handling than those which are unshelled.

Because of the smaller amount of space required it is more economical to store nuts in the shelled condition but due to their greater perishability after shelling, it is common practice to shell only as required by the trade.

Factors such as temperature, humidity, moisture content of the nuts, treatment with antioxidants, heat treatment and packages of various kinds have been studied with regard to their effect on the shelf life of shelled nuts in these investigations.

Materials and Methods

Nuts of different varieties and from various production areas were used. Included were Schley and Stuart pecans from Georgia and Burkett and Halbert from Brownwood, Texas; Placentia and Franquette walnuts from California and Oregon respectively, Barcelona filberts from Oregon and Virginia Runner peanuts from Virginia.

The nuts were furnished either by growers or one of the trade associations engaged in the marketing of nuts and were obtained immediately after harvesting and curing. Some were shelled with commercial equipment and others with a small hand sheller in the laboratory. The shelled nuts were kept in storage at 32° F., during the few days which elapsed before treating or packaging for test.

Samples of the experimental lots were withdrawn from storage at selected intervals and submitted to a taste panel for evaluation of flavor and texture (crispness). Quality ratings were scored on a scale from 1 to 10. A score of 10 indicated no detectable off-flavor, 7 indicated the beginning of noticeable off-flavor and 4 or below decided off-flavors and unacceptable quality.

Oil was extracted from a portion of each sample at the time of taste examination and was used for chemical determination of peroxide number, Kreis value and in some cases free fatty acid and iodine number. In the earlier work the oil was extracted with an organic solvent but this method proved to be unsatisfactory due to difficulty in removal of solvent and in all samples run during the past year the oil was pressed out of the kernels with a Carver press and filtered before analysis.

Results and Discussion

Effect of Storage Temperature on Quality

It is well known that nuts retain their delicate flavor and other desirable characteristics much longer if stored at a cool temperature, preferably under refrigeration during the summer. This is true for all nuts, although the rate of loss in quality is more rapid in some kinds than others and in the shelled product more so than in unshelled. The relative rates at which pecans, walnuts and filberts lose their fresh flavor and palatability when stored at 70° F. and 32° is shown in Table 1. Samples were examined at intervals of 3, 6 and 12 months and those which were borderline or below in acceptability at the time of any examination were usually discarded without further storage. Shelled pecans and walnuts at 70° were barely acceptable after three months but filberts were much more stable. The original quality of the Franquette walnuts was rather poor and dropped more rapidly during storage than that of the Placentia variety. These differences in behavior of the two lots of walnuts may be the result of climatic conditions during the growing or harvesting season. Walnuts held under vacuum at 32° for one year were superior in quality to those packed similarly but stored at 70°. The same difference in keeping quality between the two varieties as was mentioned above was also apparent in the vacuum packed lots. Filberts held under vacuum lost very little in quality at either 32° or 70°.

Effect of Packaging on Quality

Most processors of nuts pack shelled nuts in fiber-board cartons holding 25 or 30 pounds. This container is relatively inexpensive and very satisfactory for many uses but has certain disadvantages for a product such as shelled nuts. Most of the cartons are not waxed and oil from the nuts seeps into and through the carton walls where it becomes rancid very quickly. Furthermore it is reported that the cartons are at times manufactured from materials which themselves have unpleasant odors that are absorbed by the nuts. A comparison was made of shelled nuts held in cardboard with those in moisture-proof cellophane, pliofilm, polyethylene, glassine paper and in metal cans under vacuum. These were stored at 32° F. and examined after 3, 6 and 12 months. The results are given in Table II.

In these tests the products packed in poly-ethylene or glassine bags and in cans under vacuum consistently rated best. Differences between polyethylene and the fiber-board carton were significant. A careful examination of the plio-film and cellophane packages during the test revealed faulty seals in some cases and this may account for the rather poor results obtained with these materials. In all types of packages filberts showed less loss in quality than either pecans or walnuts under a given set of conditions.

A new type of container developed for the bulk storage and shipping of shelled nuts was included in this test and the results with it were very promising. This container consists of an inner bag of glassine-kraft paper in the 30 pound fiber-board carton now in general use. After the bag was filled, the open end was folded and secured with a few small staples thus obtaining a resonably tight closure. The glassine prevented seepage of oil from the nuts into the carton wall, eliminated the need for cardboard separators and prevented the nuts from absorbing objectionable odors from the container. Shipping tests with this container resulted in very little breakage of the kernels due to the fact that the product is packed much more compactly than with the conventional type package.

Antioxidants

A number of products known as antioxidants have been developed within recent years, small quantities of which added to oils or fats, retard the development of rancidity. Results have been reported of experiments with the use of one of these (B H A) on shelled peanuts. Two methods of application were described. In one of these the antioxidant was added to the cooking oil used for oil-roasting peanuts. In another case it was added to the salt used for preparing salted peanuts. The treatments in both cases improved shelf life and reduced the rate of rancidity development as compared with untreated controls stored under the same conditions.

In this laboratory some of the more common antioxidants were applied to raw nuts which were then stored for various periods. Solutions of these antioxidants (NDGA, BHA and Tyox) were applied to the nuts in the form of a spray. The concentrations and solvents used are indicated in Table III. The quantity used in some of the early tests was too high with the result that the bitter flavor of the antioxidants predominated in all of the tests for quality. In another series, smaller amounts were used and in these cases there was a slight preference for the treated samples over those which were not treated after storage of 12 months. Another series is now in progress but there is not yet sufficient data available from which to draw any conclusions.

A substantial quantity of broken kernels are produced during commercial shelling operations. These are screened out and sold as "pieces". The cartons in which they are packed soon become soaked with oil and the pieces become rancid very quickly due to the large amount of surface exposed to air. It was hoped that the application of antioxidants would be of value in prolonging the shelf life of this product. However, the results on several experimental lots have been very erratic and no positive conclusions could be drawn from the data obtained.

Effect of Storage Humidity on Quality

Shelled pecans were held in desiccators over saturated salt solutions containing an excess of the salt. The salts used and concentrations chosen were such that the relative humidities maintained were 42, 60 and 83 percent, respectively. These samples were placed in a room at 35° F. Similar lots at 42 and 70 percent relative humidity were stored in a 70° room. Results of quality examinations of these samples after 10 months storage are given in Table IV.

The pecans held at 42 percent relative humidity and 35° F. dropped from 4.56 percent moisture at time of storage to 3.46 after storage and were dry, crisp and generally more acceptable than those held at higher humidities. Those at 60 percent humidity were also considered very good quality but the nuts at 83 percent relative humidity became soft and tough. Storage at 42 percent humidity, although keeping the product in good physical condition was not practicable in commercial operations due to weight losses which would occur. In the case of these particular nuts this amounted to about 1 percent of the total weight.

Heat Treatment of Nuts and its Effect on Storage Life of Nuts

In the 1938 report of the Chief of the Bureau of Chemistry and Soils it was stated that the enzyme catalase is somewhat effective in keeping oil-bearing foods from becoming rancid, and that catalase bearing products such as oat flour, rice bran, rice polish and nuts remained free from rancidity as long as the catalase was potent. More recently McGlamery and Hood (1951) have investigated the effect of heating nuts to a temperature sufficient to inhibit enzyme activity as a means of retarding rancidity development. They showed that unshelled pecans heated to 80° C., and then cooled quickly retained their flavor and over-all palatability to a significantly higher degree than unheated control samples over a period of 24 weeks storage in an unheated room (temperature not given). Kreis values and peroxide numbers on oils extracted from the heated samples were significantly lower than on the unheated controls.

In this laboratory some experiments were made on the keeping quality of heat-treated shelled pecans in which the nuts were heated in an oven at 123° C. until the internal temperature of the kernels reached 80° C. This required about 45 minutes, after which the nuts were cooled quickly in front of an electric fan. During the heating period the nuts dropped from 6.00 to 1.75 percent moisture. The samples were packed in polyethylene bags and stored at 32° F. Results of examinations after 3 and 12 months storage are shown in Table V.

The heated samples were preferable to the unheated controls in flavor and texture at the end of each storage period. It is possible that higher acceptability of the heated product may be due in part at least to the fact that it was dry and more crisp than the control lot.

Insect Damage

Storage of nuts at a temperature under 50° F. or packaging in gas-tight containers under vacuum or filled with an inert gas will prevent damage by insects. Experimental packages of shelled pecans, peanuts and walnuts in sealed glass jars and moisture proof bags (not under vacuum or gas-filled) have been held in the laboratory at 70° F. and above for several months with no development of insects. Similar samples in sealed cardboard boxes became infected within a few weeks.

Table I. Effect of Storage Temperature on Shelf Life of Shelled Nuts

Variety	Stor. Temp. ° F.	Package	Flavor Rating After Storage 1/			Peroxide Value After Storage 2/		
			3 mo.	6 mo.	12 mo.	3 mo.	6 mo.	12 mo.
Pecans - (Schley)	32	Polyethylene-200 3/	7.2	7.1	6.7	1.37	1.81	2.79
"	70	"	3.6	4.1	---	---	4.26	---
"	32	Cellophane-450 MST 4/	7.5	8.3	5.2	---	1.97	2.79
"	70	"	4.3	3.4	---	---	7.79	---
Walnuts-Franquette	32	Polyethylene-200	7.2	6.9	6.9	2.19	1.39	8.29
"	70	"	4.7	4.1	2.8	2.94	---	7.94
"	32	Cellophane-450 MST	8.0	7.8	4.2	2.08	1.89	10.82
"	70	"	3.9	3.0	---	3.31	---	---
Walnuts-Placentia	32	Polyethylene-200	7.7	7.9	7.2	1.79	1.98	5.17
"	70	"	4.9	4.5	---	3.86	2.64	---
"	32	Cellophane-450 MST	8.0	8.3	7.1	2.03	1.87	4.17
"	70	"	5.2	4.8	---	1.77	---	---
Filberts-Barcelona	32	Polyethylene-200	7.0	6.7	6.5	Trace	Trace	Trace
"	70	"	5.8	5.7	5.4	Trace	---	Trace
"	32	Cellophane-450 MST	7.4	7.5	6.5	Trace	Trace	Trace
"	70	"	6.0	5.1	---	Trace	---	Trace
Walnuts-Franquette	32	Vacuum	7.7	6.7	6.5	2.47	---	4.06
"	70	"	5.5	4.4	2.8	3.54	---	14.21
Walnuts-Placentia	32	"	7.8	8.0	5.0	2.17	---	5.45
"	70	"	7.8	7.8	6.8	1.49	---	4.54
Filberts-Barcelona	32	"	7.2	7.8	6.8	Trace		Trace
"	70	"	6.9	7.6	6.2	"		"

1/ A score of 10 indicated highest quality, 7 indicated the beginning of noticeable off-flavor and 4 or below decided off-flavor and unacceptable quality.
2/ An increase in peroxide value usually indicates the beginning of rancidity.
3/ 200 gauge (0.0020")
4/ 450 gauge (0.0045")

Table II. Effect of Package on Shelf Life of Shelled Nuts

(Storage Temperature - 32° F.)

Package	Flavor Rating After Storage			Peroxide Value After Storage		
	3 mo.	6 mo.	12 mo.	3 mo.	6 mo.	12 mo.
Pecans-(Schley)						
Cellophane-450 MST	7.5	8.3	5.2	---	1.97	2.79
Pliofilm-N2-140	6.9	6.1	4.8	---	2.29	2.79
Polyethylene-200	7.2	7.1	6.7	1.37	1.81	2.79
Glassine	7.1	6.7	7.2	---	2.74	---
Fibreboard	6.9	6.7	4.5	1.12	1.93	2.78
Walnuts-(Franquette)						
Cellophane-450MST	8.0	7.8	4.2	2.08	1.89	10.82
Pliofilm-N2-140	7.1	7.7	4.6	2.32	---	12.57
Polyethylene-200	7.2	6.9	6.5	2.19	1.39	8.29
Fibreboard	7.2	5.6	5.0	2.56	1.30	8.04
Vacuum	7.7	6.7	6.5	2.47	---	4.06
Walnuts-(Placentia)						
Cellophane	8.0	8.3	7.1	2.03	1.87	4.72
Pliofilm	7.6	7.4	5.6	1.46	---	3.42
Polyethylene	7.7	7.9	7.2	1.79	1.98	5.17
Fibreboard	7.6	7.5	6.1	1.42	1.87	5.88
Vacuum	7.8	8.0	8.1	2.17	---	5.45
Glassine-Kraft-30#pkg.	---	---	7.1	---	---	6.26
Stored in the shell(check)	---	---	7.3	---	---	4.76
Filberts-(Barcelona)						
Cellophane-450 MST	7.4	7.5	6.5	Trace	Trace	Trace
Pliofilm, N2-140	7.1	7.1	6.4	"	"	"
Polyethylene-200	7.0	6.7	7.0	"	"	"
Fibreboard	6.6	5.7	6.0	"	"	"
Vacuum	7.2	7.8	6.8	"	---	"

Table III. Effect of Antioxidants on Shelf Life of Shelled Nuts

Antioxidant	Quantity Antioxidant Used as Percent of Weight of Nuts	Solvent	Package	Stor. Temp. °F.	Flavor Rating After Storage		
					3 mo.	6 mo.	12 mo.
Pecans							
None (Control)	----	----	Glass Jar	70	7.9	5.6	5.0
Tenox II 1/	0.035	Propylene Glycol	"	70	7.5	5.6	5.0
NDGA 2/	0.070	Ethyl Alcohol	"	70	8.1	4.4	3.3
None (Control)	----	----	Cellophane 450 MST	32	7.5	8.3	5.2
Tenox II	0.002	Propylene Glycol	"	32	7.7	7.7	5.9
Tyox 3/	0.035	Isopropyl Alcohol	"	32	---	7.2	6.3
None (Control)	----	----	"	32	7.3		
Tenox II	0.023	Isopropyl Alcohol	"	32	5.2		
"	0.002	Propylene Glycol	"	32	7.3		
"	0.023	Isopropyl Alcohol	"	70	6.2		
"	0.002	Propylene Glycol	"	70	5.7		
Walnuts							
None (Control)	----	----	"	32	7.5		
Tenox II	0.023	Isopropyl Alcohol	"	32	8.3		
"	0.023	"	"	70	8.2		
Filberts							
None (Control)	----	----	"	32	7.6		
Tenox II	0.023	Isopropyl Alcohol	"	32	7.3		
None (Control	----	----	Cellophane K 202	70	7.8		
Tenox II	0.023	Isopropyl Alcohol	"	70	7.8		

1/ Butylated hydroxyanisole, citric acid and propyl gallate in propylene glycol
2/ Nordihydroguaiaretic acid
3/ Thiodipropionic acid and Di "Lauryl" thiodipropionate

Table IV. Effect of Storage Humidity of Shelled Pecans

Storage Temperature ° F.	Relative Humidity %	Moisture Content of Nuts After 10 Months of Storage 1/	Flavor Rating after Storage
35	42	3.46	10.00
35	60	4.98	8.40
35	83	5.99	6.70
70	42	4.62	1.70

1/ Moisture at time of storage 4.56%

Table V. Effect of heat treatment of shelf life of shelled nuts

	Flavor Rating After Storage	
	3 mo.	12 mo.
Unheated Control	5.2	4.5
Heated to 80° C.	6.0	5.5